Evolutionary Acquisition (EA) Spiral Development (SD) Systems Engineering Methodology

NDIA SED Conference

20 October 2003

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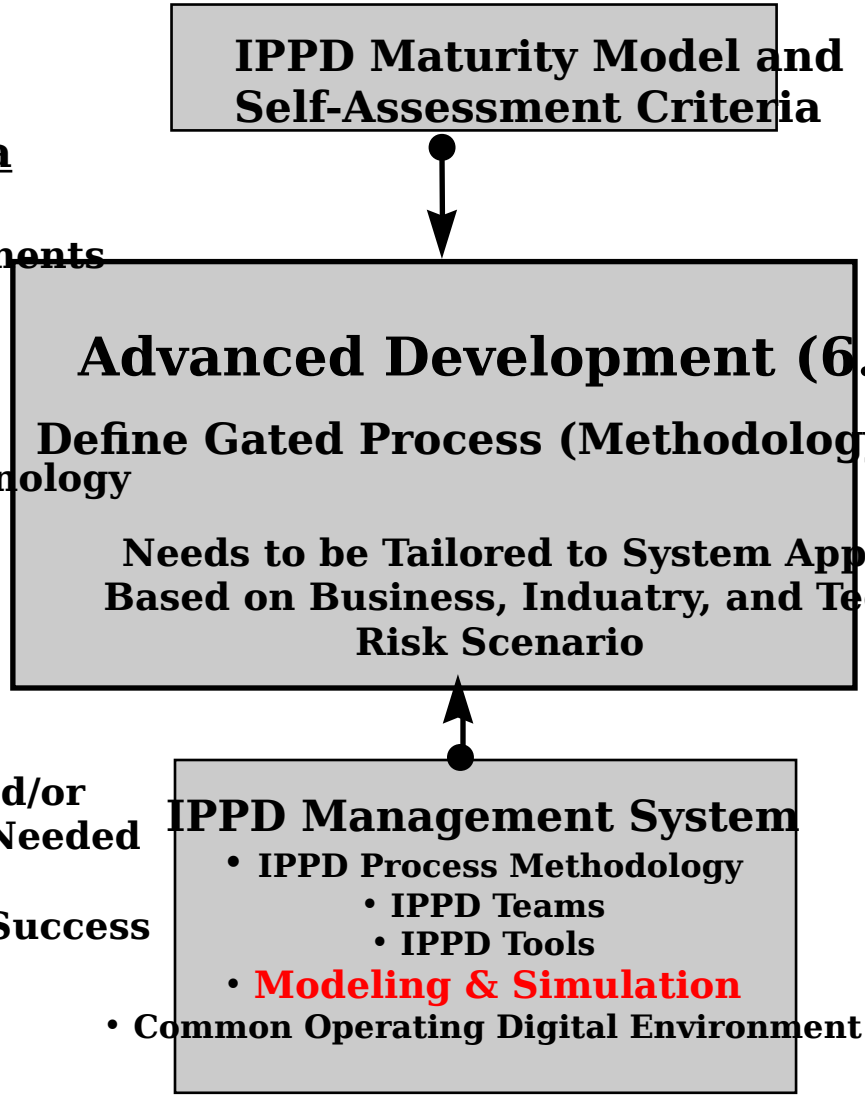
RLEngwall & Associates

Industry Recommended DoD IPPD P



Entrance Criteria

- **Customer(s) Requirements**
  - Multi-use
  - Dual-use
  - Top level
- **State-of-the-Art Technology Assessment**
  - Sub-systems
  - Components
  - Materials
  - Processes
- **Identify High Risk and/or Payoff Technologies Needed**
- **Establish Metrics of Success**

Exit Criteria

- **Generic Technologies R for Integration into Nev Production Application**
  - ATD product is operational suitable for use as fieldable prototype
  - ATD product to be manufact with production equipment, t processes and tested in real and simulated operationa environments
- **Product/Process Capabi Defined**
  - Producibility Goals
  - Life Cycle Cost
  - Reliability & Maintainability
  - Supportability
- **Materials Characterized**
- **Alternative Product/Pro Design Tradeoffs Condu Evaluated and Prioritize**

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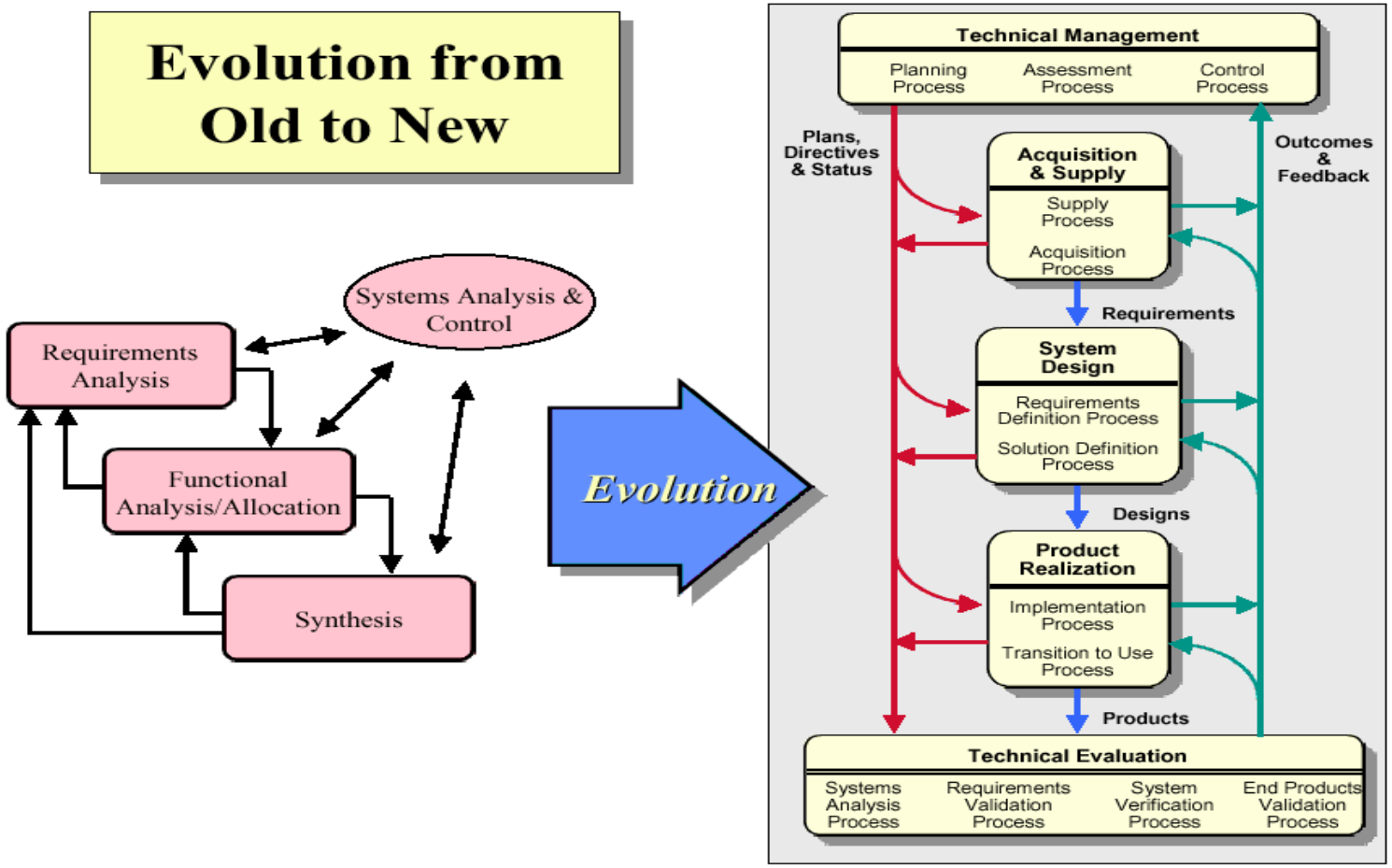
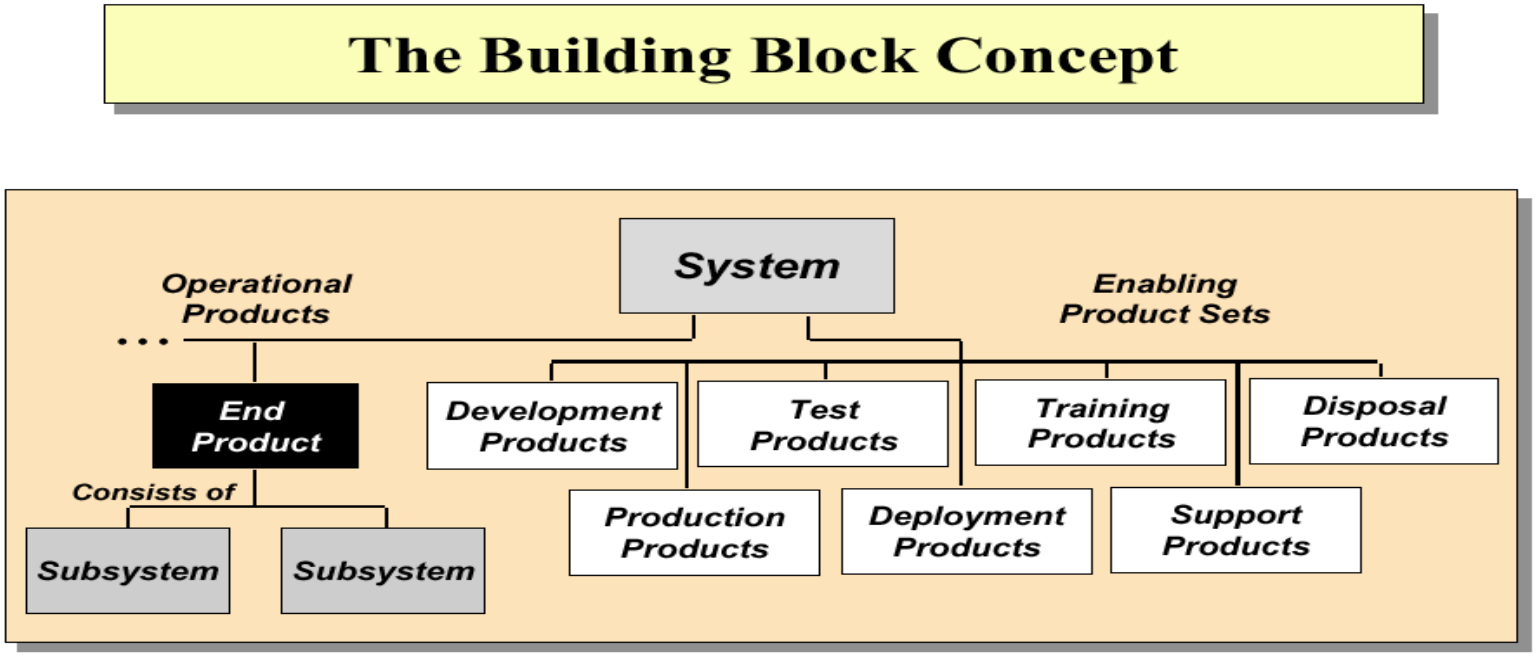
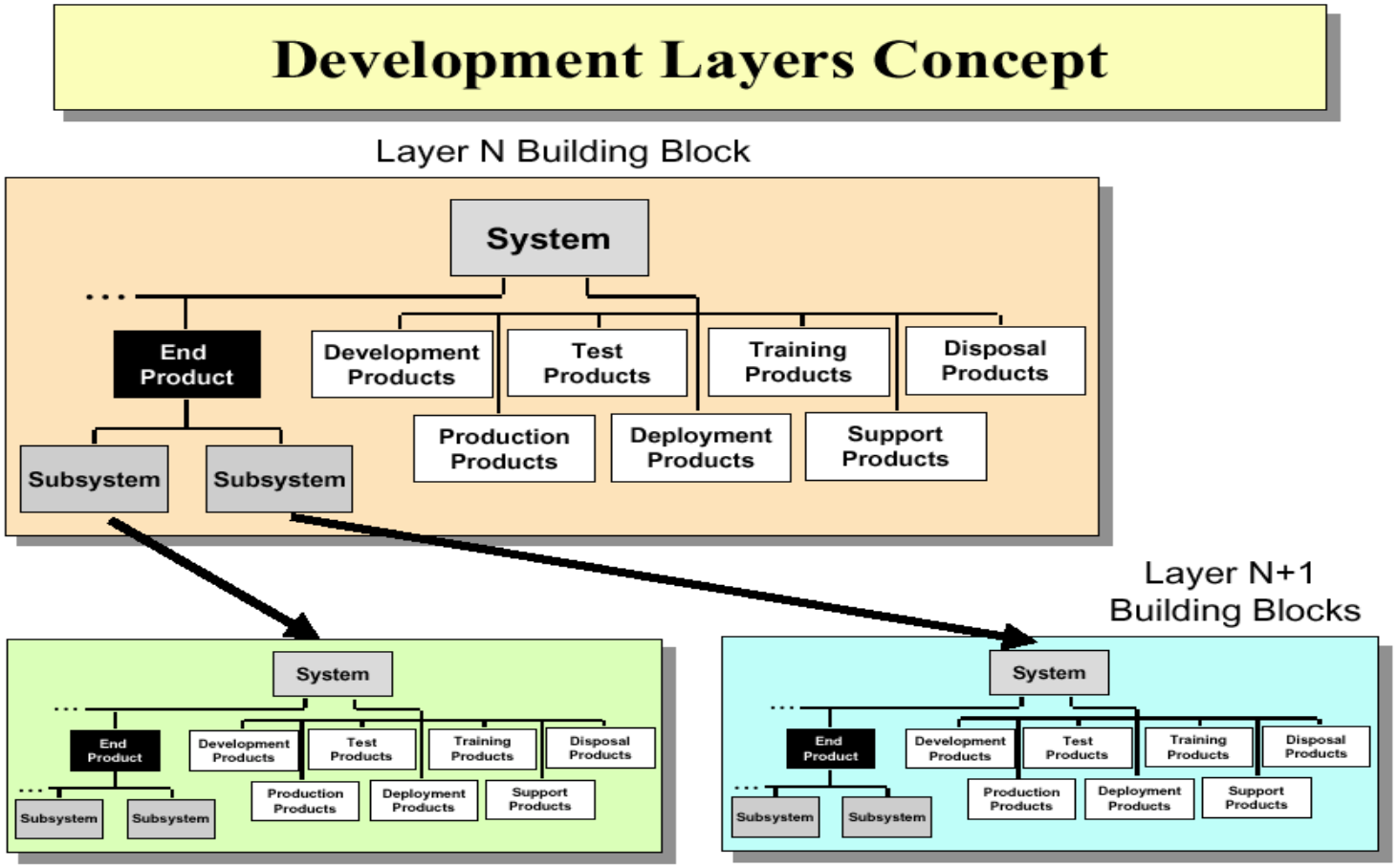
Evolution of MIL STD 499B to ANSI/EIA 632



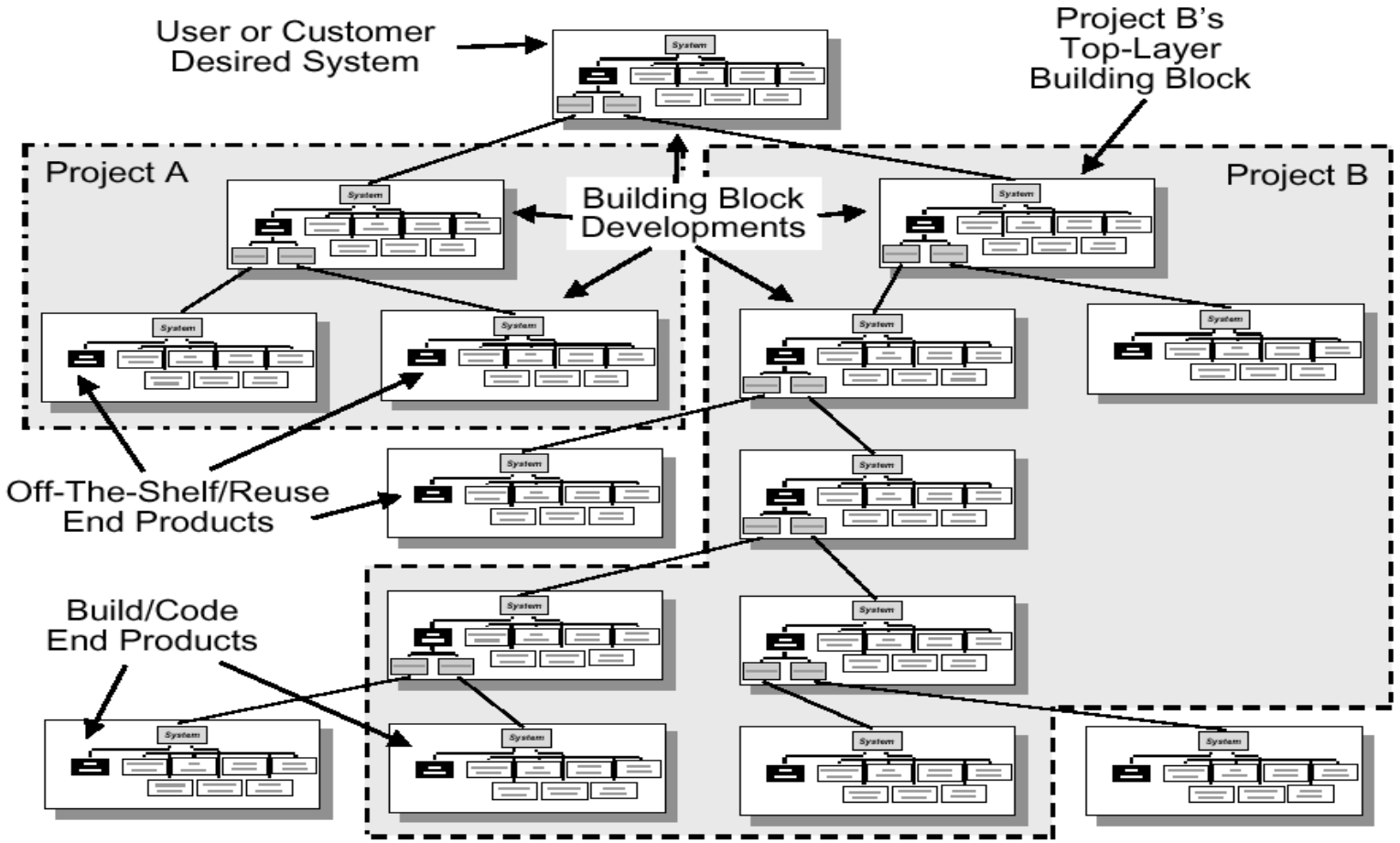
The Systems Engineering Building Block Concept



The System Engineering Development Building Block Lavers Concept



Sample Layered Development System Structure



ANSI/EIA-632 Process Requirements for Engineering a System

Supply Process Requirements
1—Product Supply

Acquisition Process Requirements
2—Product Acquisition
3—Supplier Performance

Planning Process Requirements
4—Process Implementation Strategy
5—Technical Effort Definition
6—Schedule and Organization
7—Technical Plans
8—Work Directives

Assessment Process Requirements
9—Progress Against Plans and Schedules
10—Progress Against Requirements
11—Technical Reviews

Control Process Requirements
12—Outcomes Management
13—Information Dissemination

Requirements Definition Process Requirements
14—Acquirer Requirements
15—Other Stakeholder Requirements
16—System Technical Requirements

Solution Definition Process Requirements
17—Logical Solution Representations
18—Physical Solution Representations
19—Specified Requirements

Implementation Process Requirements
20—Implementation

Transition to Use Process Requirements
21—Transition to Use

Systems Analysis Process Requirements
22—Effectiveness Analysis
23—Tradeoff Analysis
24—Risk Analysis

Requirements Validation Process Requirements
25—Statements Validation
26—Acquirer Requirements Validation
27—Other Stakeholder Requirements Validation
28—System Technical Requirements Validation
29—Logical Solution Representations Validation

System Verification Process Requirements
30—Design Solution Verification
31—End Product Verification
32—Enabling Product Readiness

End Products Validation Process Requirements
33—End Products Validation

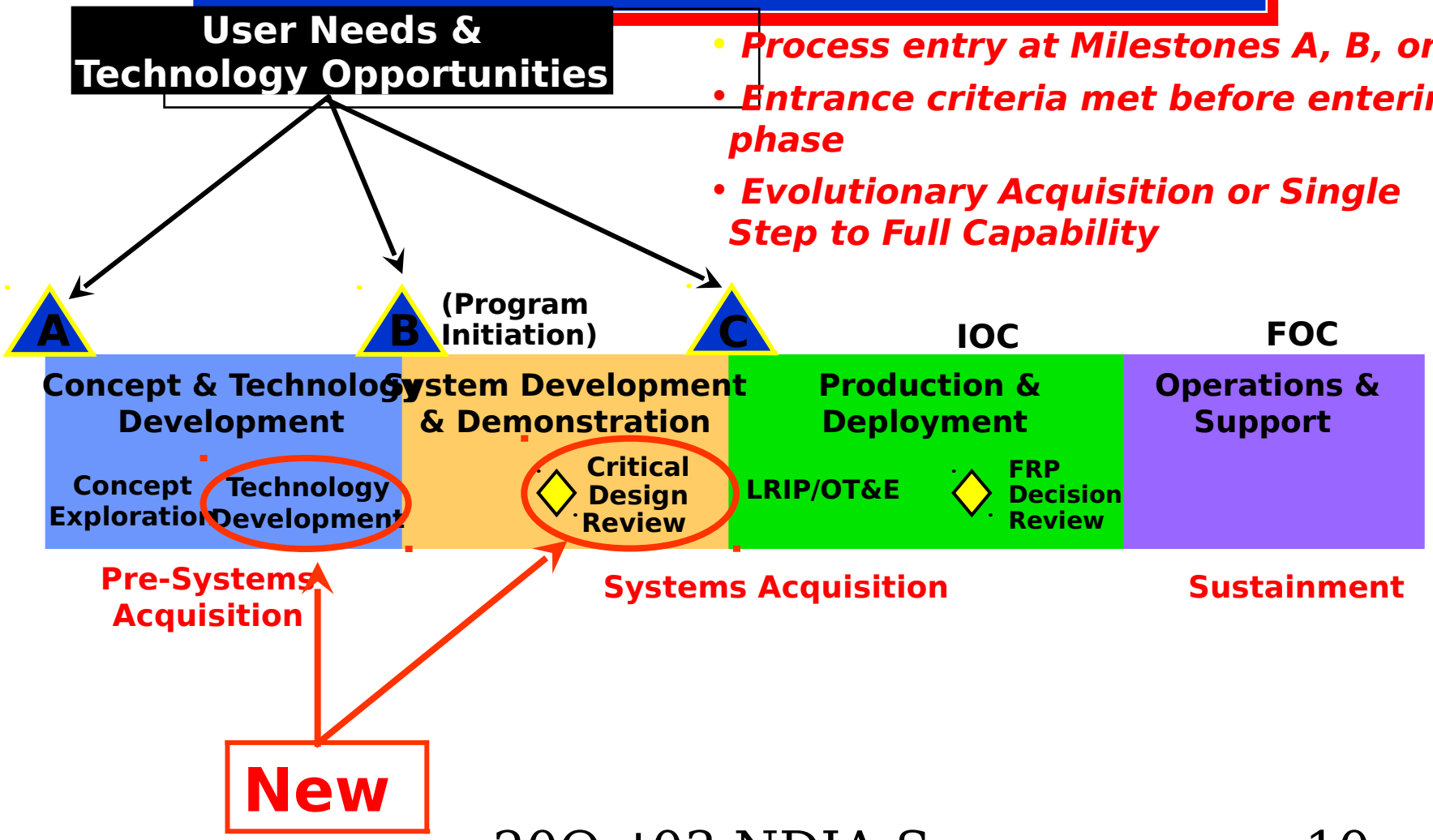
Application Guidelines of ANSI/EIA-632 (What not How Oriented)

- **Decide Which of the 33 Processes Apply**
- **Decide Which Requirements Apply for the Processes Selected**
- **Establish Appropriate Policies & Procedures**
- **Define Appropriate Tasks for Each of the Selected Requirements**

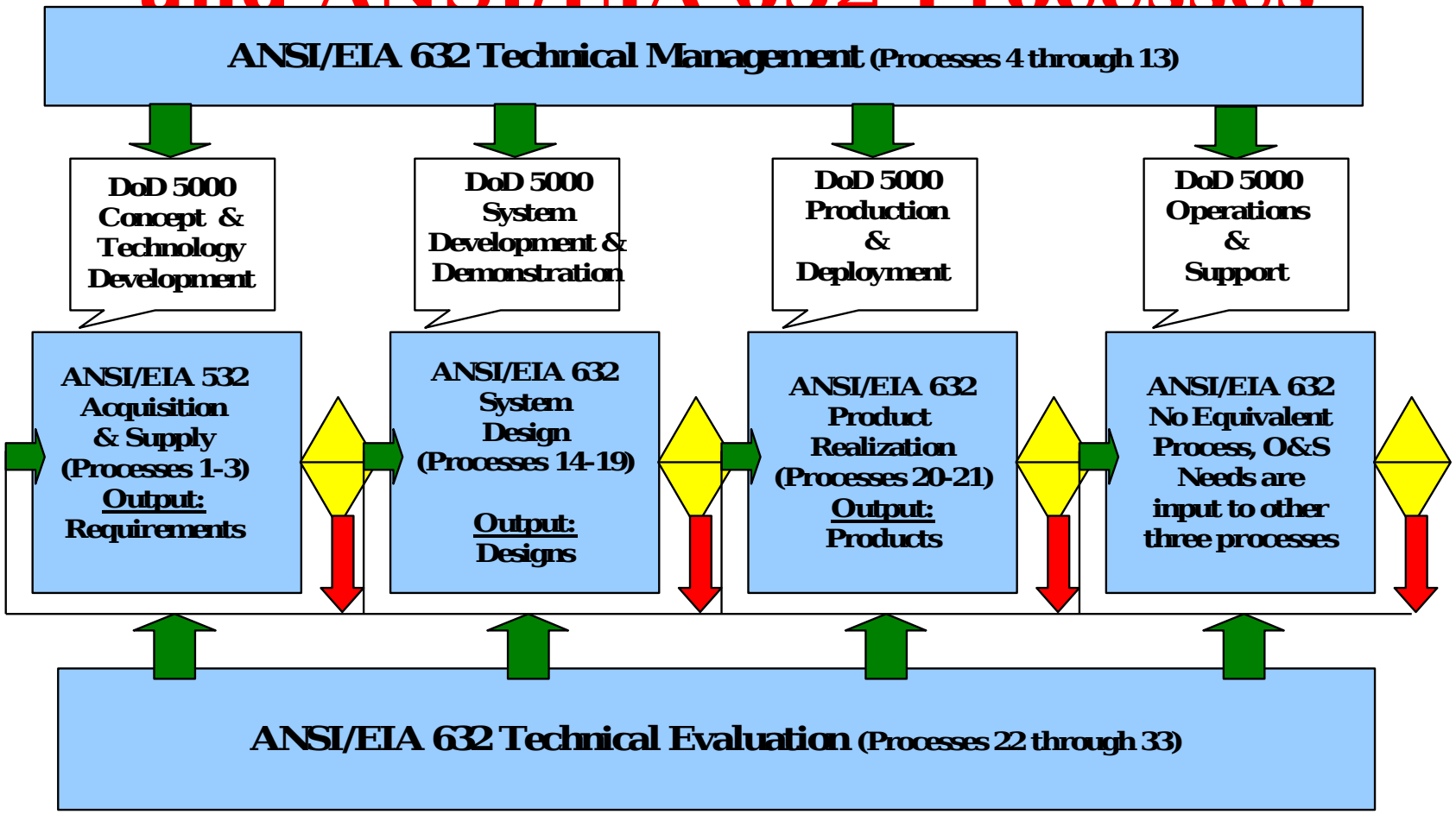
Application Guidelines of ANSI/EIA-632 (What not How Oriented) Continued

- **Establish Methods and Tools to Support Task Implementation**
  - **Representative Tasks Along With Their Expected Outcomes Are Provided in Annex C**
- **Appropriate Processes Are Applied Recursively and Iteratively**
- **Many Associate Tasks Are Concurrent And Highly Iterative And Have Interactive Dependencies That Lead To Alteration Of Previously Established Technical Requirements**

The 'Newer' 5000 MODEL



Interdependency of DoD 5000 and ANSI/EIA 632 Processes


ANSI/EIA 632 Technical Management (Processes 4 through 13)
DoD 5000 Concept & Technology Development
DoD 5000 System Development & Demonstration
DoD 5000 Production & Deployment
DoD 5000 Operations & Support
ANSI/EIA 532 Acquisition & Supply (Processes 1-3) Output: Requirements
ANSI/EIA 632 System Design (Processes 14-19) Output: Designs
ANSI/EIA 632 Product Realization (Processes 20-21) Output: Products
ANSI/EIA 632 No Equivalent Process, O&S Needs are input to other three processes
ANSI/EIA 632 Technical Evaluation (Processes 22 through 33)

Concept & Technology Development Phase

Concept Exploration

Enter: Validated & approved ICD

- **Activity: Paper studies of alternative solutions to the initial concept**

Exit: MDA selects preferred solution to be pursued

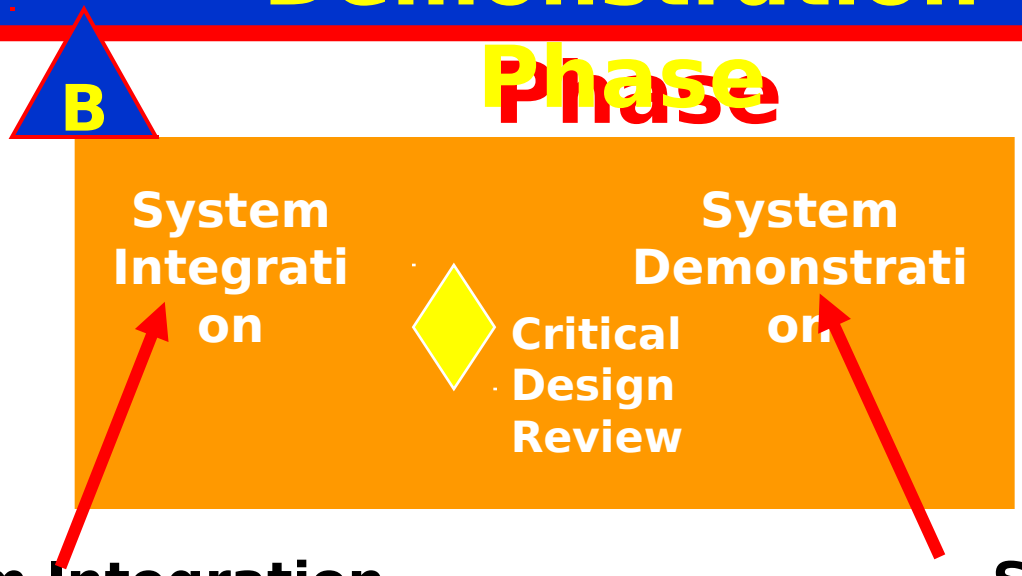
Technology Development

Enter: Project leader understands solution as part of the integrated architecture and its DOTMLPF implications.

- **Activity: Technology development demonstrations**

Exit: Affordable increment of military-useful capability identified and demonstrated in relevant environment – normally can be developed for production within 5 years

System Development & Demonstration



System Integration

Enter: PM has technical solution but has not integrated subsystems into complete system

- **Activities: System Integration of demonstrated subsystems and components. Reduction of integration risk.**

Exit: Demonstration of prototypes in relevant environment

System Demonstration

Enter: Prototypes demonstrated in intended environment

- **Activities: Complete development. DT/OT/LFT&E**

Exit: System demonstration in intended environment using engineering development models; meets validated requirements

Production & Deployment Phase

LRIP

Enter: System matured for production

- **Activities: Low-rate initial production. IOT&E, LFT&E of production-representative articles. Establish full manufacturing capability.**

Exit: System operationally effective, suitable and ready for full rate production

Full-Rate Production & Deployment

Enter: Beyond LRIP (ACAT I) and LFT&E reports (covered systems) submitted to Congress

- **Activities: Full rate production.**

Deploy system. Start support.

Exit: Full operational capability; deployment

Operations & Support Phase

Sustainment

Sustainment starts immediately upon fielding or deployment.

- **Activities: Maintain readiness and operational capability of deployed system(s). Execute operational support plans. Conduct modifications and upgrades to hardware and software. Measure customer confidence.**

Disposal

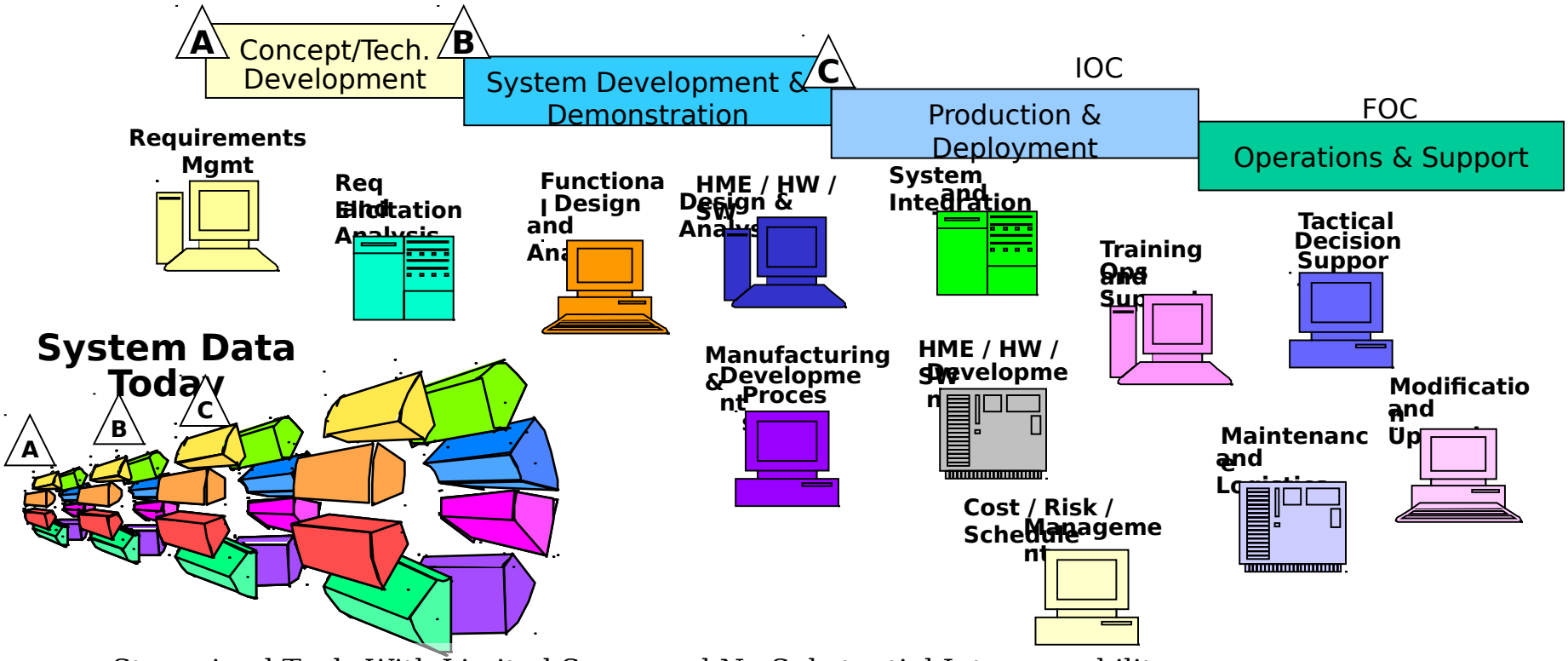
Demilitarization & Disposal

- **Activities: Demilitarize and dispose of systems IAW legal and regulatory requirements, particularly environmental considerations. Use Defense Reutilization and Marketing Office support, as appropriate.**

EA/SD System Engineering Impact on Information Systems

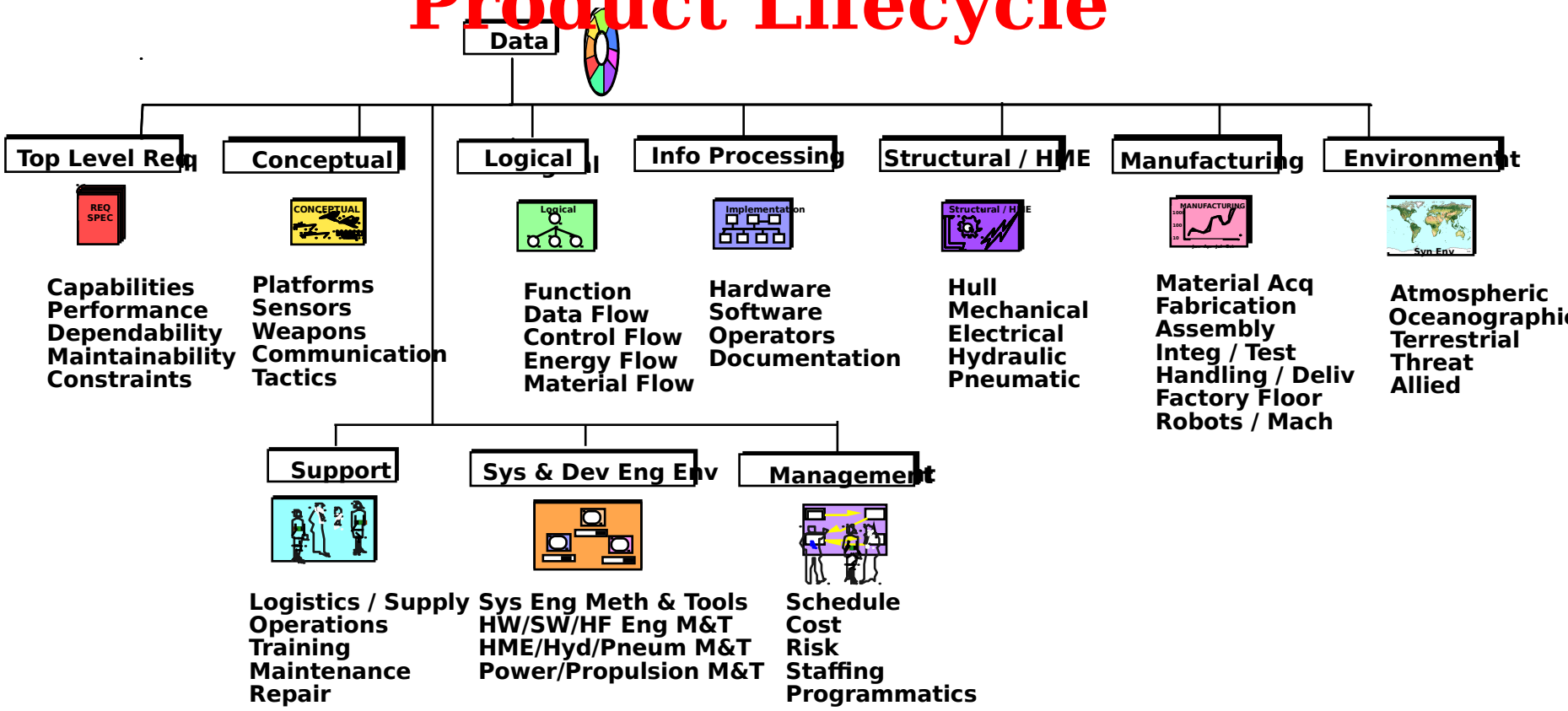
- **Need to Capture System Information Once in Common Interoperable Format**
- **Apply Distributed Tools for Collaborative Assessment & Optimization Including Pervasive Modeling & Simulation Throughout the System Engineering Product Life Cycle**
- **Utilize ANSI/EIA-632 Technical Management and Technical Evaluation Processes Throughout the DoD Acquisition Process**
- **A Broad, Extensible Representation Approach Is Key**
  - **Use EIA-927 Common Data Schema For Complex Systems**

The Complex Systems Tower of Babel



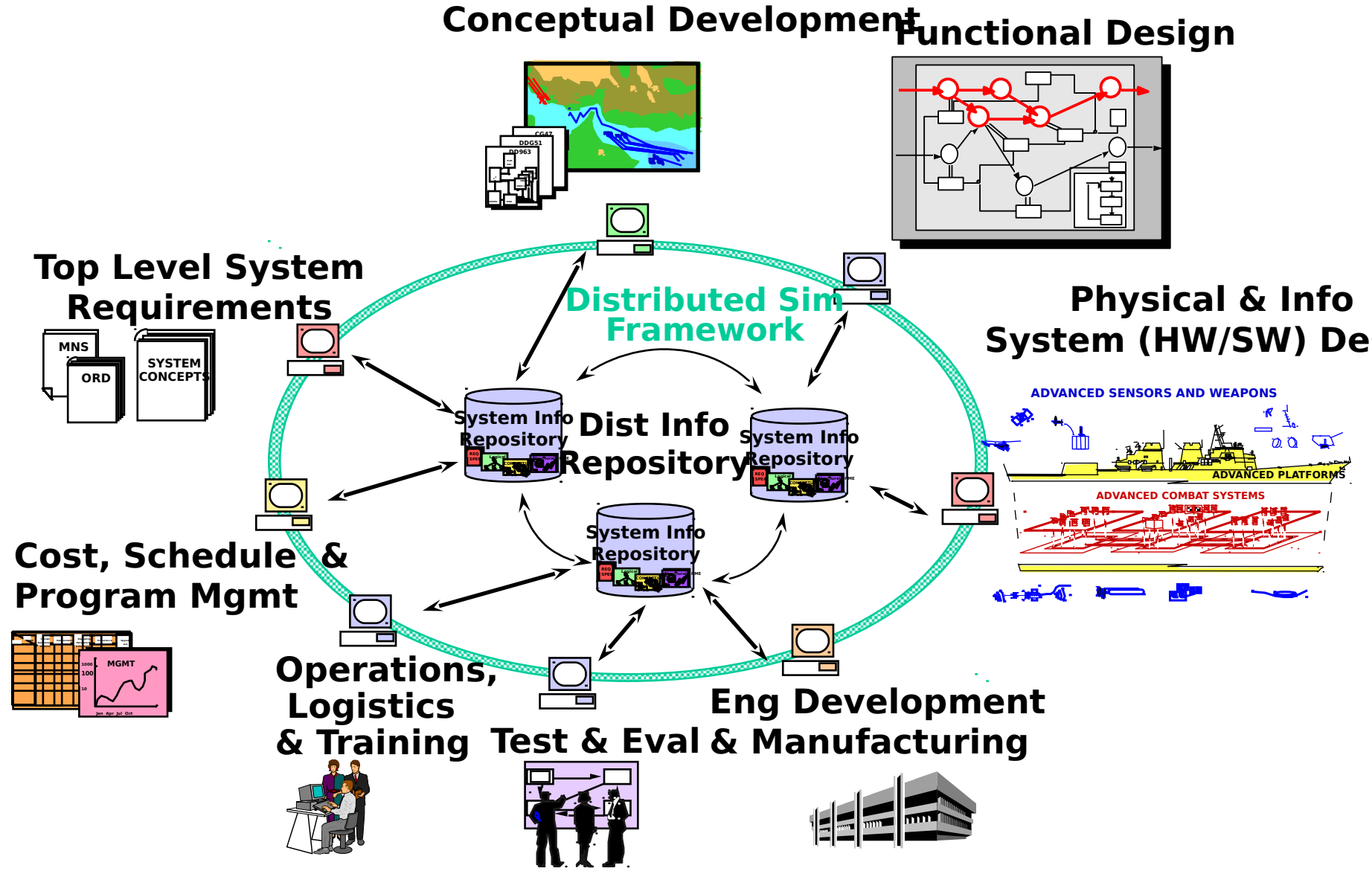
- Stovepiped Tools With Limited Scope and No Substantial Interoperability
- Multiple Independent Files and Databases With Ad Hoc Manual Configuration Management, Traceability, and Consistency Checking across Domains
- Most PDM and Enterprise Management Solutions are *File* Based and Fail to Provide any Useful Integration of the *Information* Stored in the Files

Common Data and Systems Across the Product Lifecycle



- **A Formal Structure for Representing Spectrum of System Data is needed**
- **A Dynamic Schema Provides Means for Accommodating Emerging Data Representation Needs**
- **A broad, extensible representation approach is key**

SBA Concept


Conceptual Development
Functional Design
Top Level System Requirements
MNS
ORD
SYSTEM CONCEPTS
Distributed Sim Framework
Physical & Info System (HW/SW) Desig
ADVANCED SENSORS AND WEAPONS
ADVANCED PLATFORMS
ADVANCED COMBAT SYSTEMS
System Info Repository
Dist Info Repository
System Info Repository
System Info Repository
Cost, Schedule & Program Mgmt
MGMT
Operations, Logistics & Training
Test & Eval
Eng Development & Manufacturing

SF Product Development Information Model (top-leve

Coherency & completeness cross-checks
- Solid lines = primary
- Dashed lines = secondary

Government provided context information

- Operational Context (scenarios, etc.)
- Blue systems
- Threat systems
- Natural environment
- Civil/military infrastructure
- Transportation capabilities

LM Aero provided Product Information Model (DPD)

(Variants = layered instance values)

Functional allocation trade studies

Logical architecture (from SE/IPT designers)
- System/ subsystem topology
- Functional allocation
- Technologies
- Interfaces

- Air vehicle performance
- Mission system capabilities
- Autonomic logistics
- Signatures
- Reliability

Performance (from IPT analysts, with gov't review)

Interactions (from Kr/gov't analysts)
- Lethality/ effectiveness
- Survivability

(Requirements are recorded in appropriate information domain)

Personnel rqmts

Support infrastructure

Maintainability

Mobility

Physical architecture (from IPT designers)
- Assemblies & components
- Software
- Spatial & electrical relationships
- Connections
- Part records

Specialized views:
- OML, Cost, BOM, mass properties, etc.

Manufacturing process

Manufacturing/ supplier capabilities

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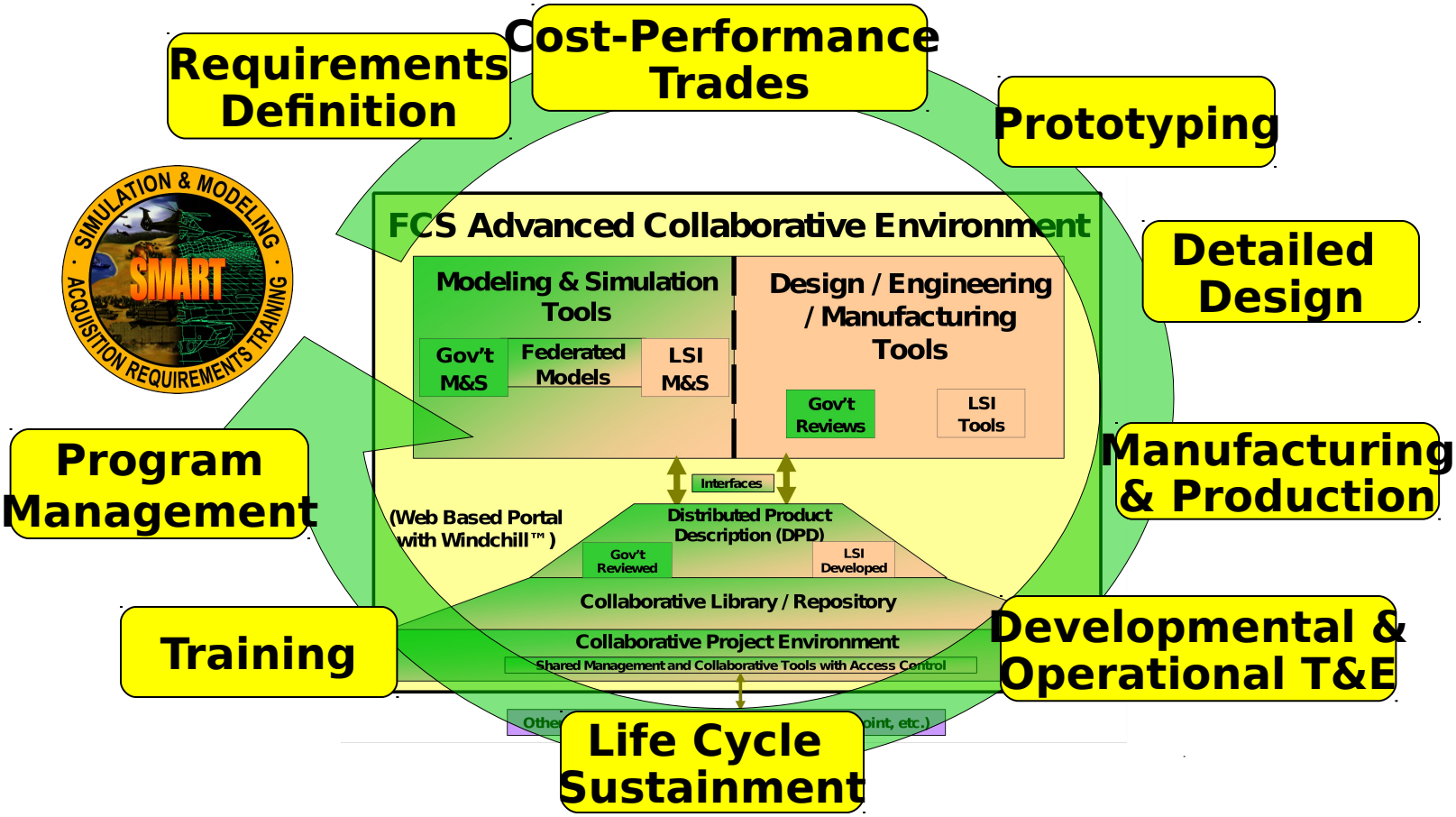
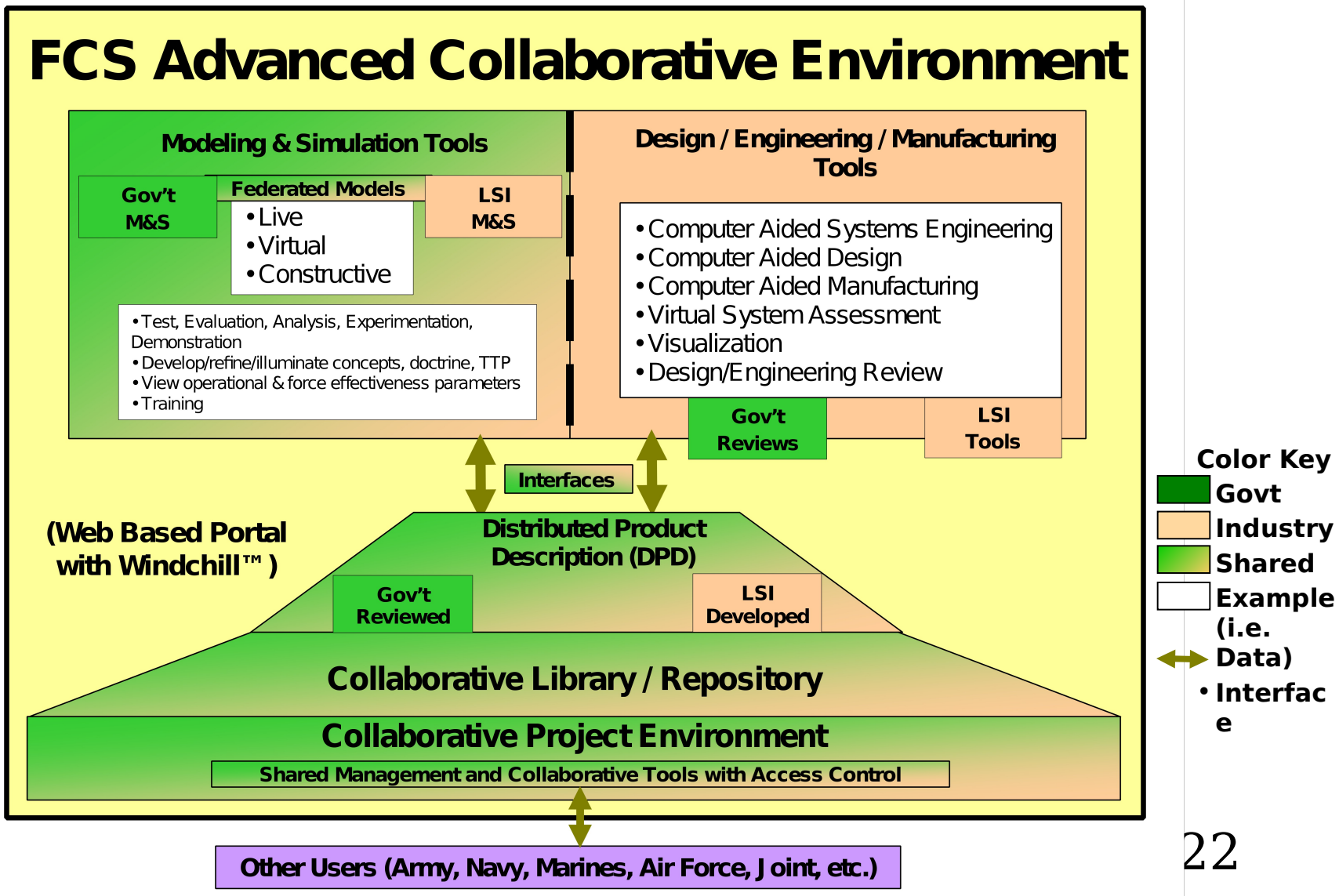
FCS ACE Enables SMART



Field FCS-Equipped Units of Action With Threshold Objective Force Capability by the End of the Decade.

FCS ACE Diagram



Questions?

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